The Science Behind the Sound

Introduction

Most people think they understand music. Almost any teenager, when asked their thoughts on music, would respond, "Music is my life." But how much do teens really know about music? Do they know why the music they're listening to sounds pleasant to their ears? Do they know exactly how that sound is produced? What effect it has on their brains? Or even how the ear can possibly hear these sounds? Music is a complex scientific phenomenon, and even scientists are still struggling to understand exactly how sound is produced and heard, why it sounds pleasant, and what effect it has on the brain.

What is Sound?

Sound Production

The experience of sound involves a compound interaction that causes noises to reach our ears. According to Harris, sound is essentially produced by vibrations in the atmosphere. When an object vibrates, it bumps into the air molecules around it, and those molecules bump into other molecules, and so on. This wave of air molecules is aptly named a sound wave. Sound can be produced by anything that can move air molecules, from a book falling on the floor to a person telling a joke.

Sound is produced by vocal chords which are located inside the larynx, or voice box. Immediately prior to producing sound, the vocal chords are closed. Air pressure builds up behind the vocal chords, and as exhalation occurs, the vocal chords separate and then come back together. This cycle occurs 200-400 times per second, and this vibration produces sound.

The Ear

Sound waves are "caught" by the outer ear, also known as the pinna. The waves bounce off the pinna and enter the ear. The ear then send electrical signals to the brain and the brain recognizes different patterns and processes them to determine where the sound is coming

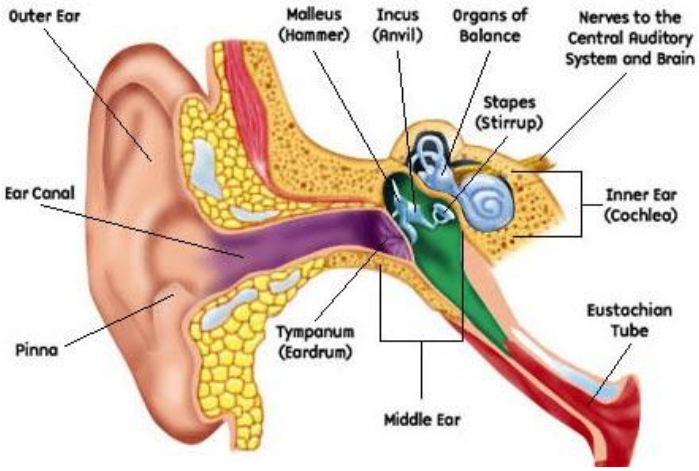

Figure 1: Diagram of the parts of the ear.

from. When these sound waves enter the ear they travel through the ear canal to the tympanic membrane or eardrum (see Figure 1). The eardrum is a ten millimeter thin cone-shaped piece of skin. It is pulled taught by the tensor tympani muscle, so that no matter where the sound wave hits it will vibrate the eardrum. This vibration of the eardrum is what allows the ear to hear. The tensor tympani muscle along with the stapedius muscle protects the ear by tensing up when the brain senses a noise. These two muscles pull the eardrum in two different directions, making it more rigid and less sensitive. This rigidity blocks out loud sounds such as rock music at a concert and allows more refined noises to be heard. The ear is able to discriminate between different noises and hear the desired sound. This is why conversation is possible at noisy events (Harris).

What makes music sound pleasing?

Pitch

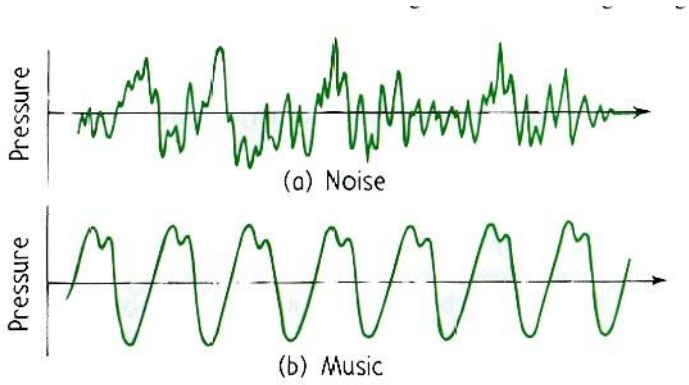

Figure 2: Difference between noise and music waves.

However, not all sound waves are equal. There is a strong difference between "noise" and music. The sound waves for noise are very rigid and jagged without a pattern to the wave. Sound waves for music are even and smooth with a regular pattern to the rise and fall of its waves (see Figure 2). This difference in sound waves allows us to differentiate between music and white noise. The regular pattern of sound waves is what makes music sound pleasant to the ears.

Harmonics

Harmony is produced when sound waves "fit together." When several high pressure sound waves and other low pressure sound waves are produced at the same

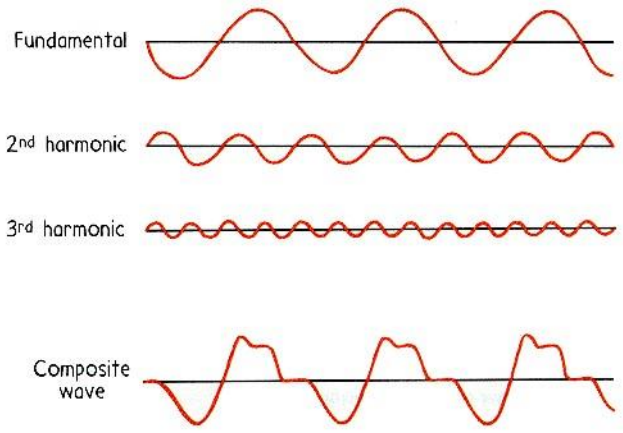

Figure 3: Sound waves reinforce each other to create one composite wave.

time, some of the waves cancel each other out (see Figure 3). The ones that are left form the complex sound wave that travels to the brain. Another factor in creating complex sound waves is amplitude, or volume and frequency, or pitch. Amplitude is determined by the size of the sound wave. To measure this, scientists measure the top half of the wave, the distance from the center to the crest, or top, of the wave. The bigger the wave, the louder it is. Conversely, frequency is how many waves occur in a second. The more waves the higher the pitch and vice versa ("Sound Waves"). However, these are not necessarily related. A sound wave can have low amplitude and high frequency, or low amplitude and low frequency. The two are not dependent on each other.

Reverb

Another factor that contributes to the pitch of a note is reverb. According to "Science of Music," when sounds bounce around and take a long time to reach the ear they produce a fuller tone, which may make a voice sound better than usual. It also allows the note to ring longer, making a sung note sound more on key. Reverb is present in a sound booth, garage, or shower. That's why people always think they sound better in their shower.

The effect of music on the brain

When these small pieces of sound come together as music, they can have a very powerful effect on physical health, as scientists are beginning to discover. As a result, music is being used in all sorts of ways. Many progressive therapists are beginning to use music to treat all sorts of disorders including high blood pressure, seizures, mental illness, ADD, and insomnia. Classical music can be very beneficial, and listening to it for thirty minutes is the equivalent of one dose of valium. One theory to explain why this happens is that the heart and breathing rates synchronize to the beat of the music. Conversely, the "wrong" kind of music, such as heavy metal and rock, can cause seizures and other illnesses. (Vaidya).

Physical Effects

In one experiment, high school students Richie and Ryan Huynh studied the effect of music on the immune system. They had eleven students listen to classical music for twenty minutes a day and compared the change in their white blood cell counts to students who did not listen to classical music over the same period of time. They discovered that listening to classical music for twenty minutes a day significantly increases the presence of disease-fighting white blood cells (Sohn).

According to the American Music Conference, teens who study music are also more emotionally stable than their non-musical peers. They react better to stress, have less performance anxiety, and are more likely to have a stronger footing on a test. They are also less likely to drink or become alcohol dependent; this is probably because they turn to music rather than alcohol to relax.

Emotional Effects

Not only does music have a significant effect on physical and emotional health, but it also positively influences brain development. This is evidenced through academic success. According to the Children's Music Workshop, "Several studies have confirmed that music directly enhances learning through increased spatial development. Math and reading are improved by learning rhythms and decoding notes and symbols." One study showed that after nine months of piano or voice training, students' IQ rose three points more than their non musical peers (Mundell).

In a 2006 study by Canadian-based researchers and summarized by Science Daily, it was discovered that musical training had a notable affect on memory and general intelligence. The research team wanted to discover how musical training would increase auditory responses, the ability to differentiate between musical tones and noise, and brain development in young children. What they discovered was that children studying music for a year improved on general, non-musical memory skills and other aptitudes such as literacy, math and IQ. Dr Laurel Trainor, Professor of Psychology, Neuroscience and Behaviour at McMaster University and Director of the McMaster Institute for Music and the Mind, said, "It suggests that musical training is having an effect on how the brain gets wired for general cognitive functioning related to memory and attention."

Conclusion

Throughout history people have had an obsession with music, and even now the specifics and inner workings of music are still not completely understood by scientists. While they are still struggling to understand exactly why music sounds pleasing and what effect it has on the human body, music clearly has a profound effect on human beings. The right or wrong music can have a direct effect on physical and emotional health. Understanding the effect of music on people is essential to understanding health.

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